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PIC Based Automatic Solar Radiation Tracker

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This document details the development of an Automatic Solar Radiation Tracker. Fossil fuels are a relatively short-term energy source; consequently, the uses of alternative sources such as solar energy are becoming more wide spread. To make solar energy more viable, efficiency of solar array systems must be maximized. A feasible approach to maximizing the efficiency of solar array systems is sun tracking. Proposed in this report is a system that controls the movement of a solar array so that it is constantly aligned towards the direction of the sun. The solar tracker designed and constructed in this project offers a reliable and affordable method of aligning a solar module with the sun in order to maximize its energy output. Automatic Sun Tracking System is a hybrid hardware/software prototype designed around Programmable Intelligent Computer (PIC), which automatically provides best alignment of solar panel with the sun, to get maximum output electricity.

Key Words: Solar Energy, Radiation Tracker, Programmable Intelligent Computer (PIC)

INTRODUCTION

This is a well-known fact that non-renewable sources are a relatively short-term energy sources; consequently, the uses of alternative sources such as solar energy are becoming more wide spread. To make the solar energy more viable, the efficiency of solar array systems must be maximized. There are several factors that affect the efficiency of the collection process. Major influences on overall efficiency include solar cell efficiency, intensity of source radiation and storage techniques. The materials used in solar cell manufacturing limit the efficiency of a solar cell. This makes it particularly difficult to make considerable improvements in the performance of the cell, and hence restricts the efficiency of the overall collection process. Therefore, the most attainable method of improving the performance of solar power collection is to increase the mean intensity of radiation received from the source. The present work includes design and development of control system that aligns the solar panel in the direction of the sun. By doing so, the panel faces the sun continually as it moves across the sky from east to west, thereby getting the maximum electrical energy possible.

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EXPERIMENTAL

Design of automatic solar radiation tracker has been an active area of solar energy researchers and has evolved over a period of time as the technology improved in electronics. An early work reported in 1983, utilized micro-computers for this tracking[1]. Later, it was replaced by more compact microprocessors[2-3]. With advent of micro-controllers, researchers started designing trackers using this technology[4-5]. Even Programmable logic controller was used for optimal tracking of solar radiations[6]. The present work is done on 16F877A Programmable Intelligent Computer (PIC), which is relatively faster and offers many built-in features that are not available in other micro-controllers.

Polycrystalline photovoltaic module is used in this system and it is designed to track the maximum sunlight by stepping motor that is commanded by PIC microcontroller to get the maximum energy out of it. The energy received by the solar panel depends on the atmospheric conditions too. For example, when outside is cloudy, the solar energy received goes down to 10% from its initial value; in this situation it is not advisable to move the solar panel. The algorithm presented by us can foresee such a situation in which the program hibernate control action till the sun reappears.

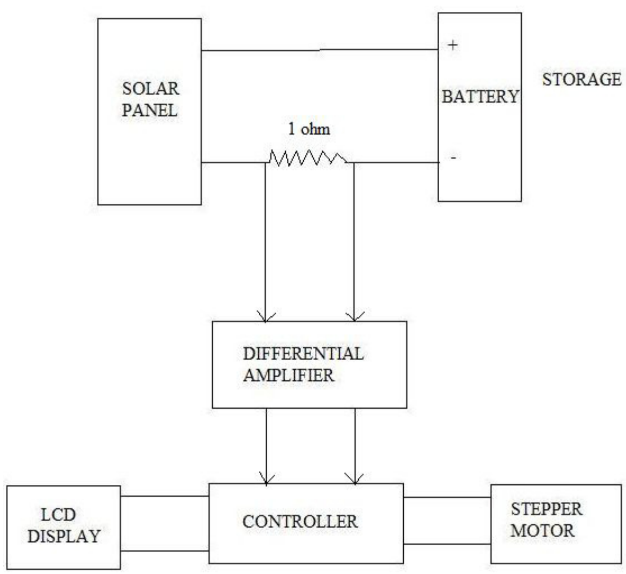

Fig. 1 Block diagram of the hardware designed.

The charging current is monitored by measuring the differential potential difference across 1 Ω resistor, as shown in Fig. 1. The controller executes program to determine the rotation of solar panel, which is achieved by giving command pulses to a stepper motor. The current is also displayed on Liquid

Crystal Display (LCD). A 12 V battery is used to store the solar energy that is periodically discharged to maintain its terminal potential through out the experiment.

General procedure:

The control strategy involves rotation of flat panel solar array with the help of stepper motors. Control signal for stepper motors is generated by a PIC (Programmable Intelligent Computer) that periodically hunts the panel westwardly till it is able to locate a maximum in radiations. The stepwise procedure followed is given below.

1. Measure in-circuit current
2. If the current is less than dark value (it indicates onset of night), reset the tracker to start position (extreme east) and sleep for 10 hours, then it go to step1
3. If the current is less than threshold value (minimal daylight current), wait for 15 minutes and go to step 1.
4. Turn panel forward by 15° and measure current again after a pause of 1 minute. If current increases, continue with rotation. If it decreases, then revert back by 15°. If it remains constant, stop rotating, wait for 15 minutes and go to step 1.

Detection Method:

This technique requires no additional sensors for tracking as the charging current from the solar panel itself guides to locate the radiation maximum.

RESULTS AND DISCUSSION

Sun moves faster over the horizon in short winter days as compared to long summer days. Therefore, the proposed feedback based system is more efficient as compared to the timer based tracker system. A comparative table for radiations collected by fixed panel vs. panel with a tracker is given in Table 1.

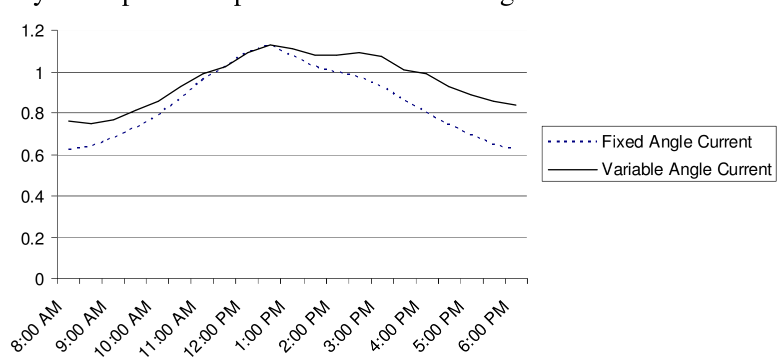

Fig. 2 Charging current in ampere for fixed and variable angles

The corresponding graph for charging current in ampere) w.r.t. time is shown in Fig. 2. Since the readings are taken for both the fixed angle and the controller computed angle, any variation on account of status of battery or that of the incident radiations, or any other random factor, is taken into account. The table shows maximum benefit in earlier and later part of the day

Table 1 Comparison of charging current for fixed and variable angle

Time	Charging current (ampere) at a fixed angle and a constant voltage of 12V	Charging current (ampere) at a variable angle and a constant voltage of 12V	%age change
8:00 am	0.62	0.76	22.5%
8:30 am	0.64	0.75	17.2%
9:00 am	0.68	0.77	13.2%
9:30 am	0.73	0.81	10.9%
10:00 am	0.79	0.86	8.9%
10:30 am	0.87	0.93	6.9%
11:00 am	0.96	0.99	3.1%
11:30 am	1.02	1.02	0%
12:00 pm	1.09	1.09	0%
12:30 pm	1.13	1.13	0%
1:00 pm	1.07	1.11	3.7%
1:30 pm	1.02	1.08	5.9%
2:00 pm	1.00	1.08	8%
2:30 pm	0.97	1.09	12.4%
3:00 pm	0.93	1.07	15.1%
3:30 pm	0.86	1.01	17.4%
4:00 pm	0.80	0.99	23.7%
4:30 pm	0.74	0.93	25.7%
5:00 pm	0.69	0.89	28.9%
5:30 pm	0.65	0.86	32.3%
6:00 pm	0.62	0.84	35.5%
	Total = 17.88	Total = 20.06	
	Average = 0.85	Average = 0.95	

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